

Expanding the SSFM dataset for ADM validation

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The Multi-angle Imaging SpectroRadiometer

9 view angles at Earth surface with 14-bit pushbroom cameras

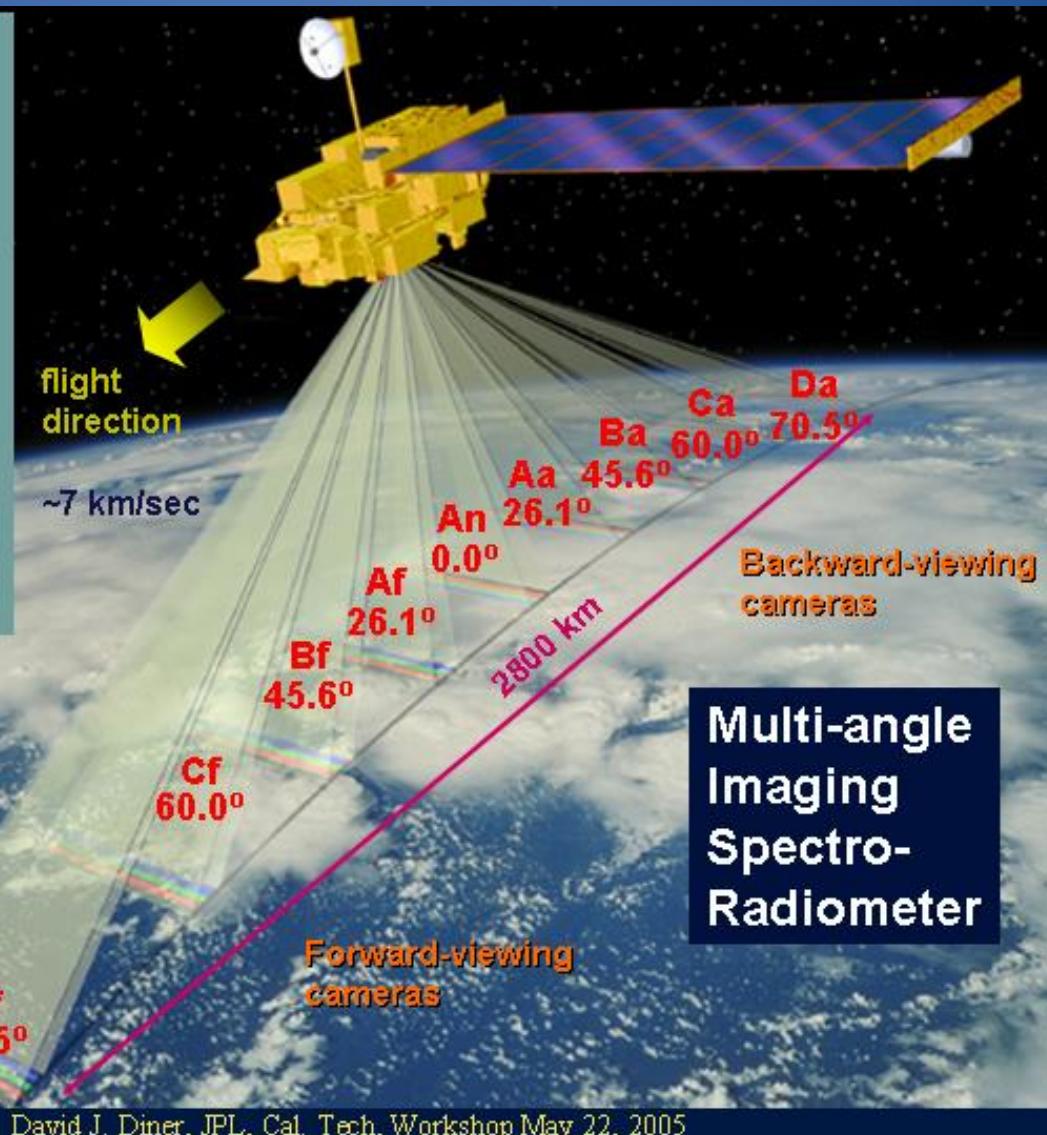
7 minutes to view each scene from all 9 angles

275 m spatial resolution per pixel

~400-km swath width

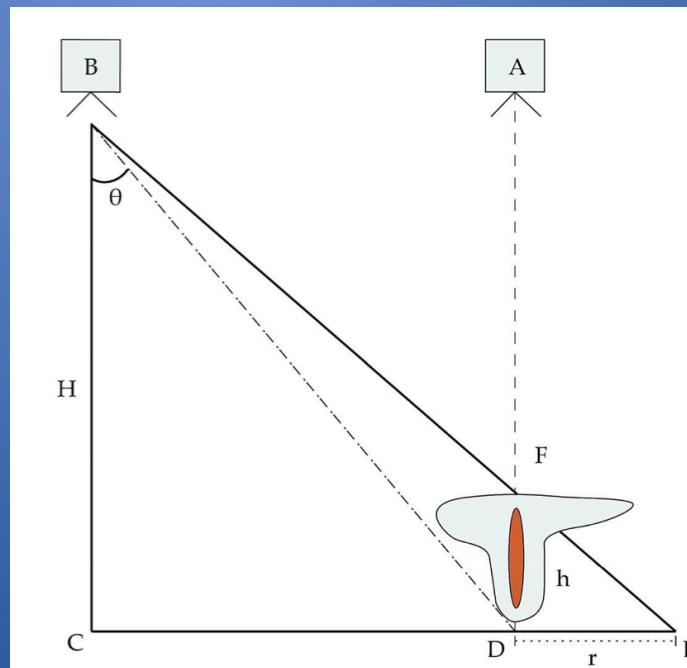
Calibrated measurements of the intensity of reflected sunlight

4 spectral bands at each angle:
446 nm \pm 21 nm
558 nm \pm 15 nm
672 nm \pm 11 nm
866 nm \pm 20 nm

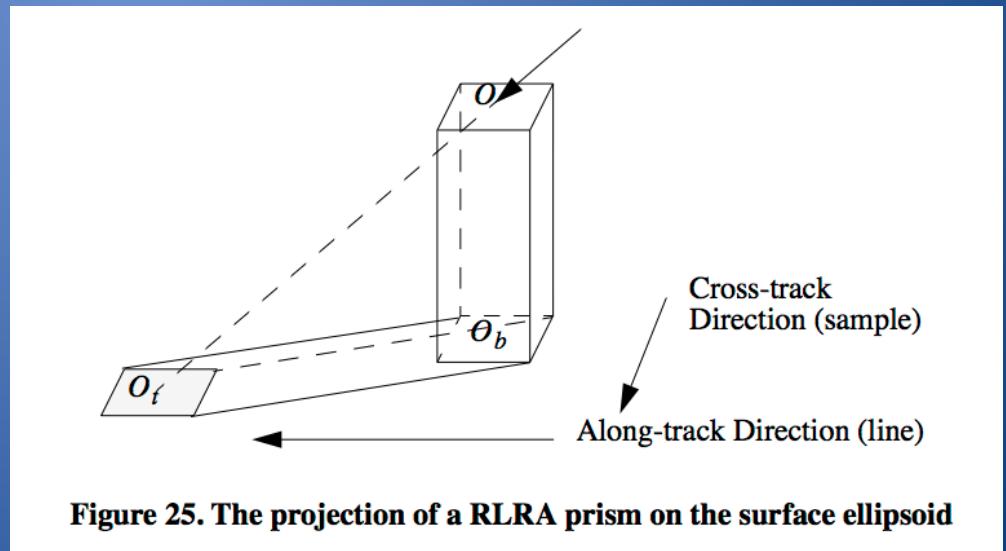


- The SSFM dataset co-locates (MISR) narrowband radiances and the CERES footprint.
 - Applies the point spread function (PSF)
 - Loeb et al 2006
- Allows us to view a CERES footprint from 9 different angles simultaneously.
- We mainly use it to examine the angular consistency of the ADMs

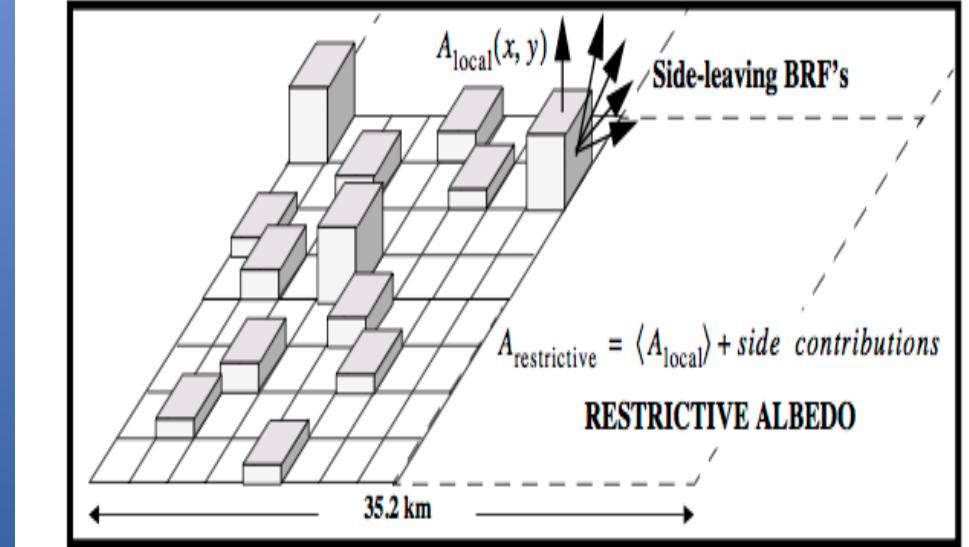
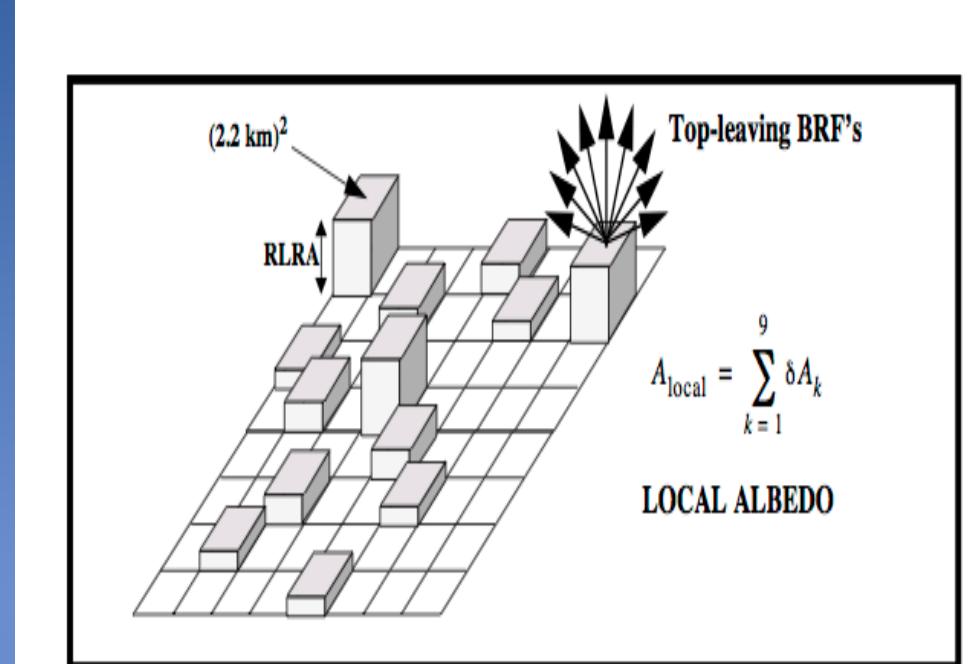
- One issue is that the SSFM dataset doesn't currently account for parallax issues.
 - MISR level 1 radiances are projected to a surface ellipsoid
 - Means that the surfaces seen are different for different cameras, especially for high clouds



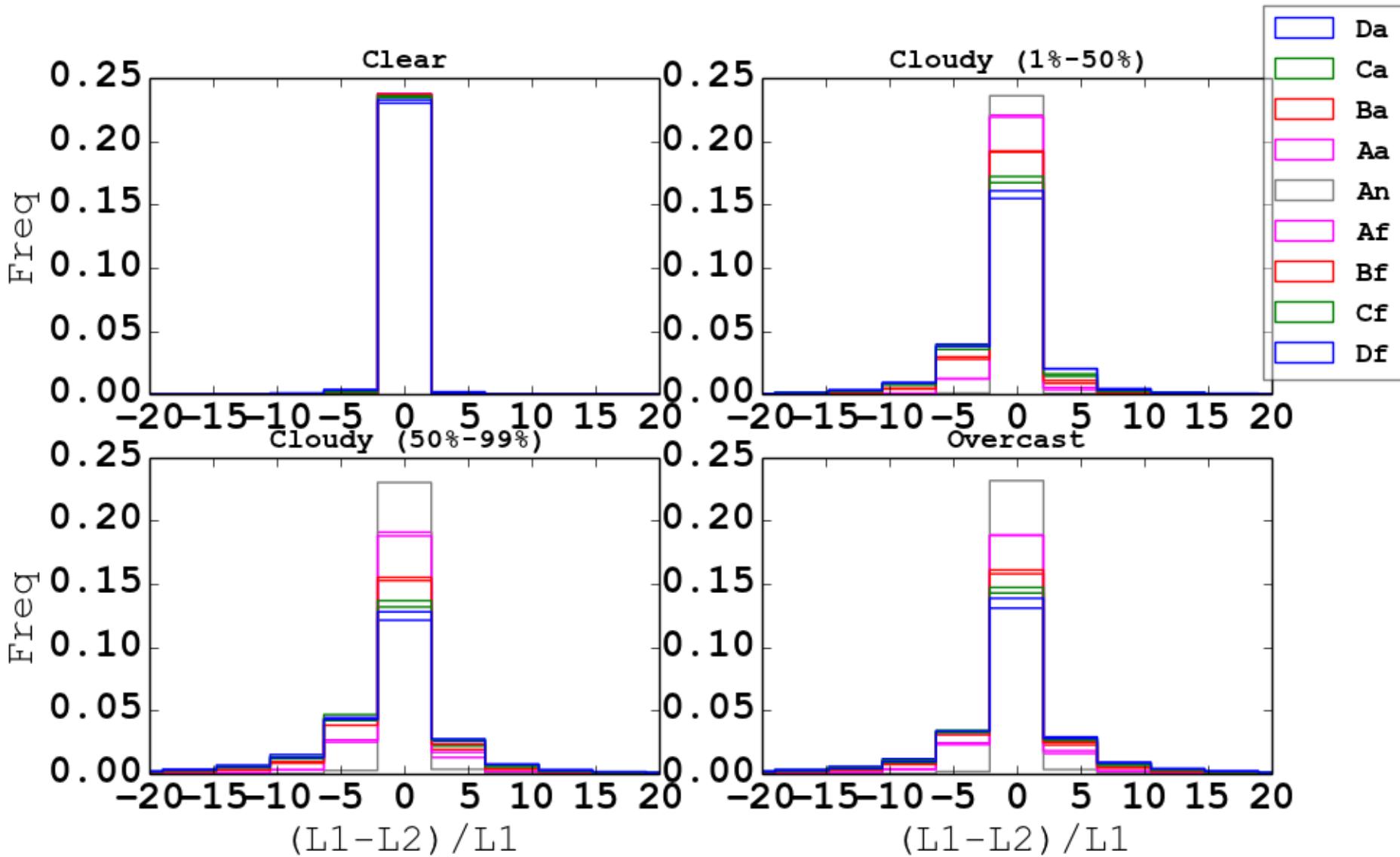
- Solution may be to use the level 2 reflectance (BRFs)
 - 2.2km area (twice that of the Level 1)
 - Projected to the reflecting level of the cloud/surface
 - Uses pattern matching to match the scene from different angles



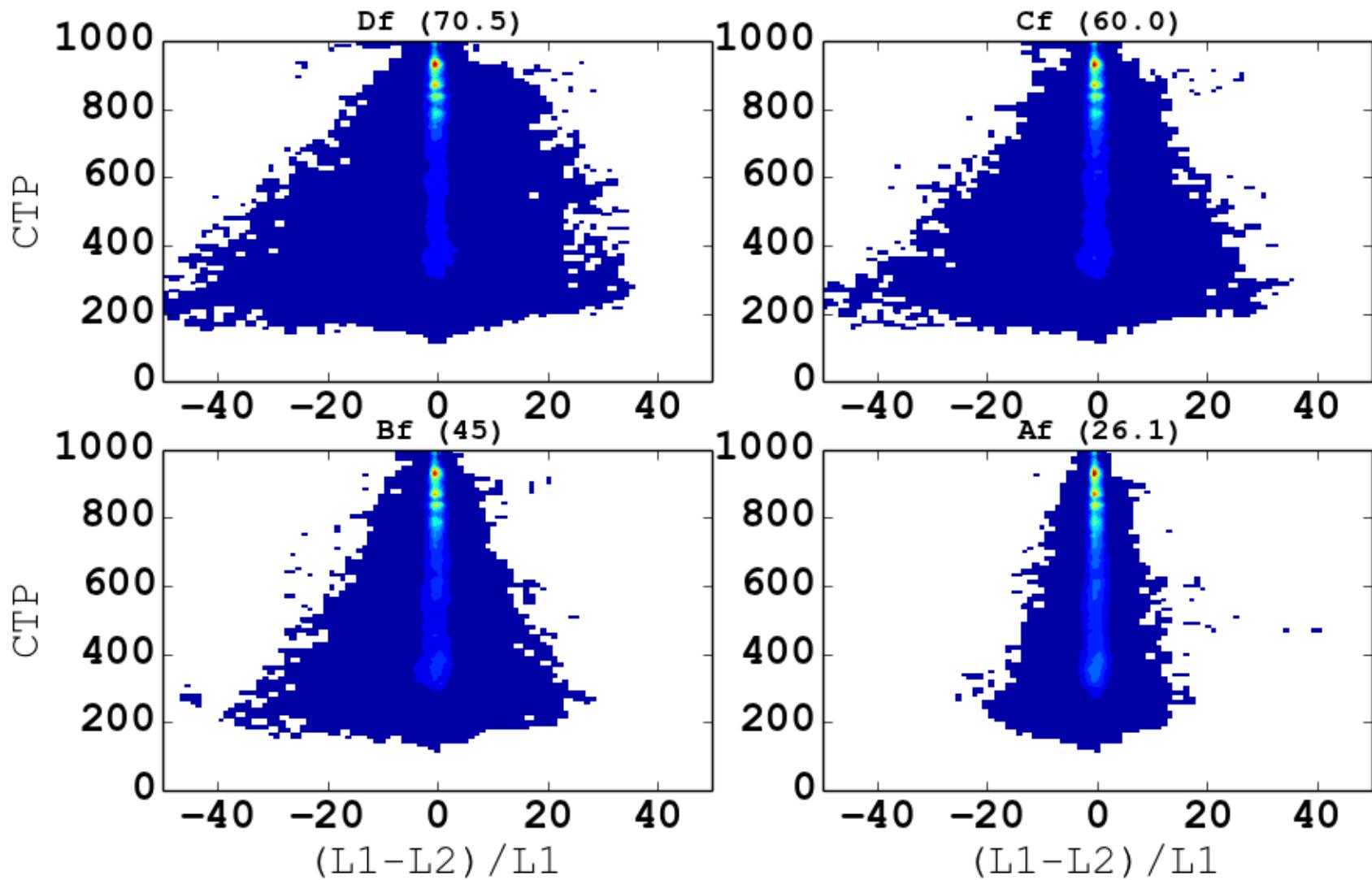
- Side-leaving BRFs are also included
 - Use a weighted average



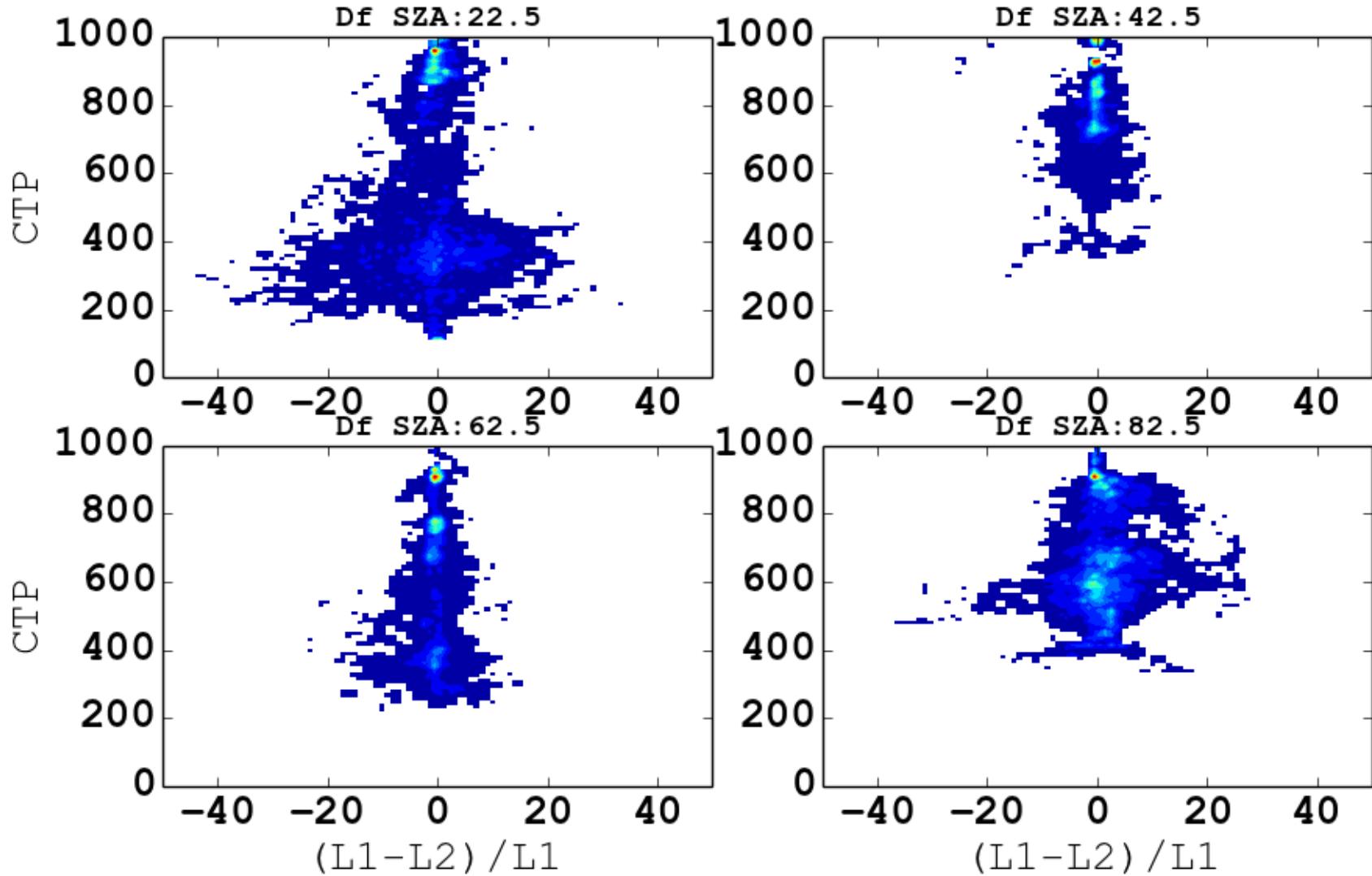
- Differences between Level1 and Level2 radiances increase with cloud fraction and camera angle



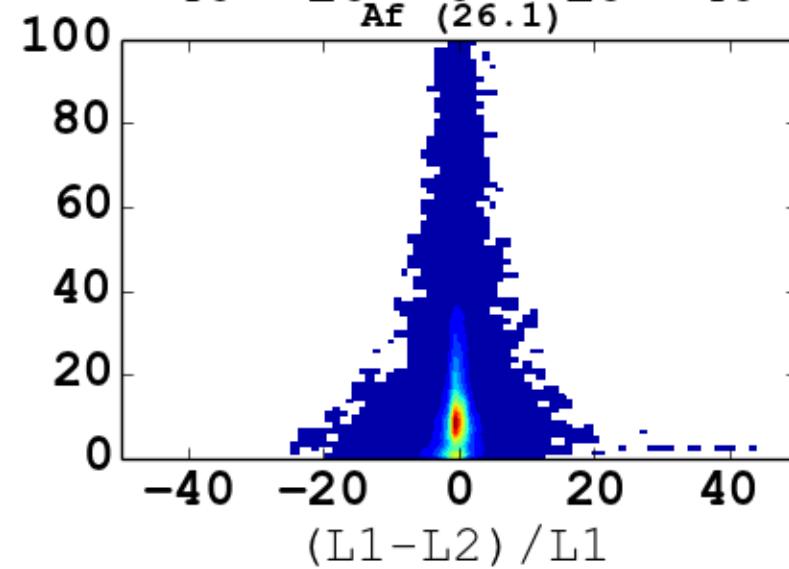
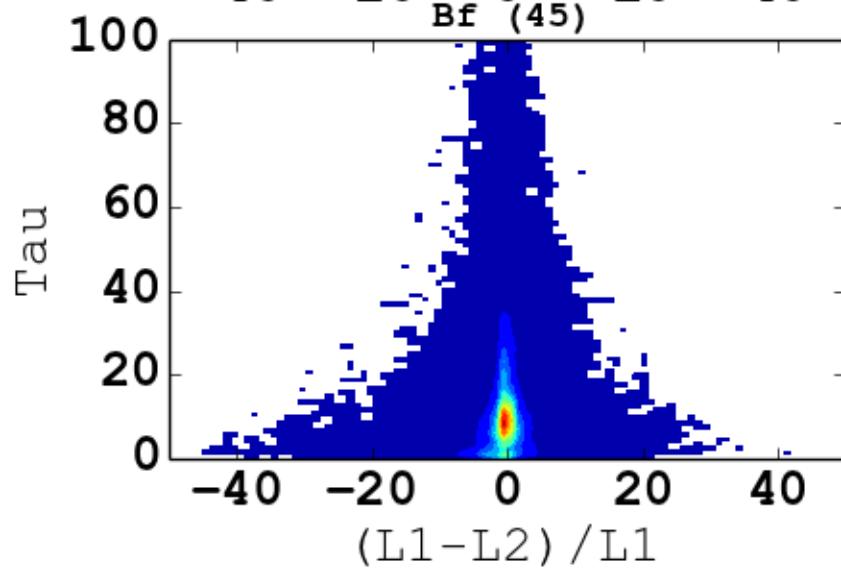
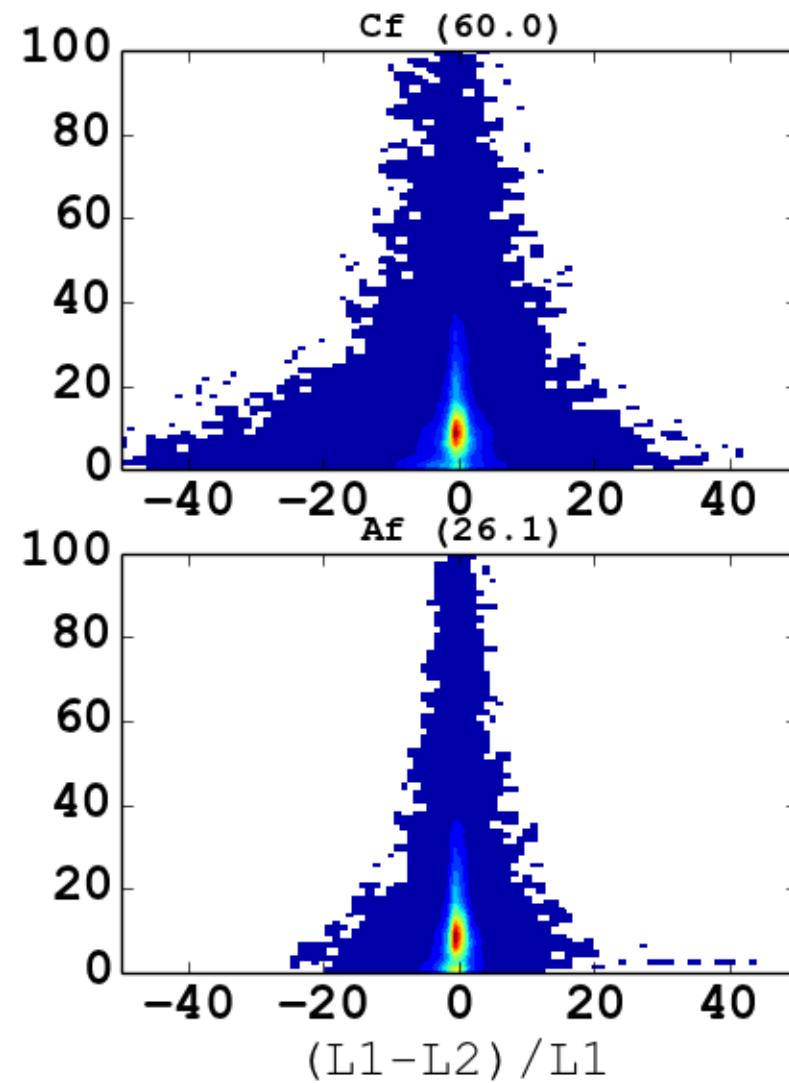
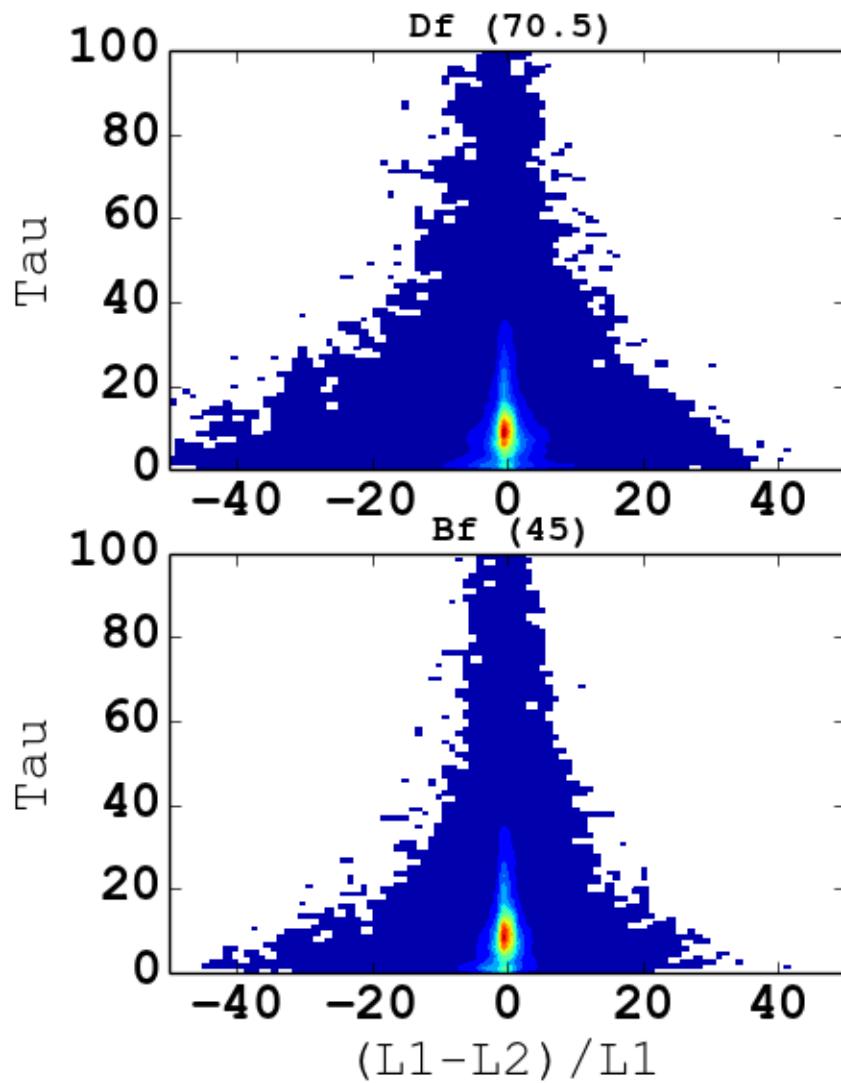
- Differences are a function of cloud height



- Effect is the strongest at lower solar zenith angles



- Low cloud optical depths have greatest differences



- To evaluate the ADMs we first use a narrow-to-broad band (nbb) conversion.

$$I_{sw}^j = c_0 + c_1 I_{0.45}^j + c_2 I_{0.67}^j + c_3 I_{0.87}^j$$

- Then apply the ADMs to the 9 MISR radiance measurements to get 9 flux estimates.
 - Use the standard deviation of the 9 as an estimate of the total error.

$$s = \sqrt{\frac{\sum_{j=1}^n (F_{sw}^j - \bar{F}_{sw})^2}{n - 1}} \quad \longrightarrow \quad CV_T = \left(\frac{\sqrt{\frac{1}{M} \sum_{i=1}^M s_i^2}}{\frac{1}{M} \sum_{i=1}^M \bar{F}_{sw}^i} \right) \times 100\%$$

- ADM error is the difference between the total and the nbb error.

$$CV_{ADM} = \sqrt{CV_T^2 - CV_{NB}^2}$$

- Using the level 2 MISR might enable us to get an estimate of the parallax error
 - Total error should include a parallax term

$$CV_T^2 = CV_{ADM}^2 + CV_{NB}^2 + CV_{PX}^2$$

- Level 2 MISR should have no parallax error

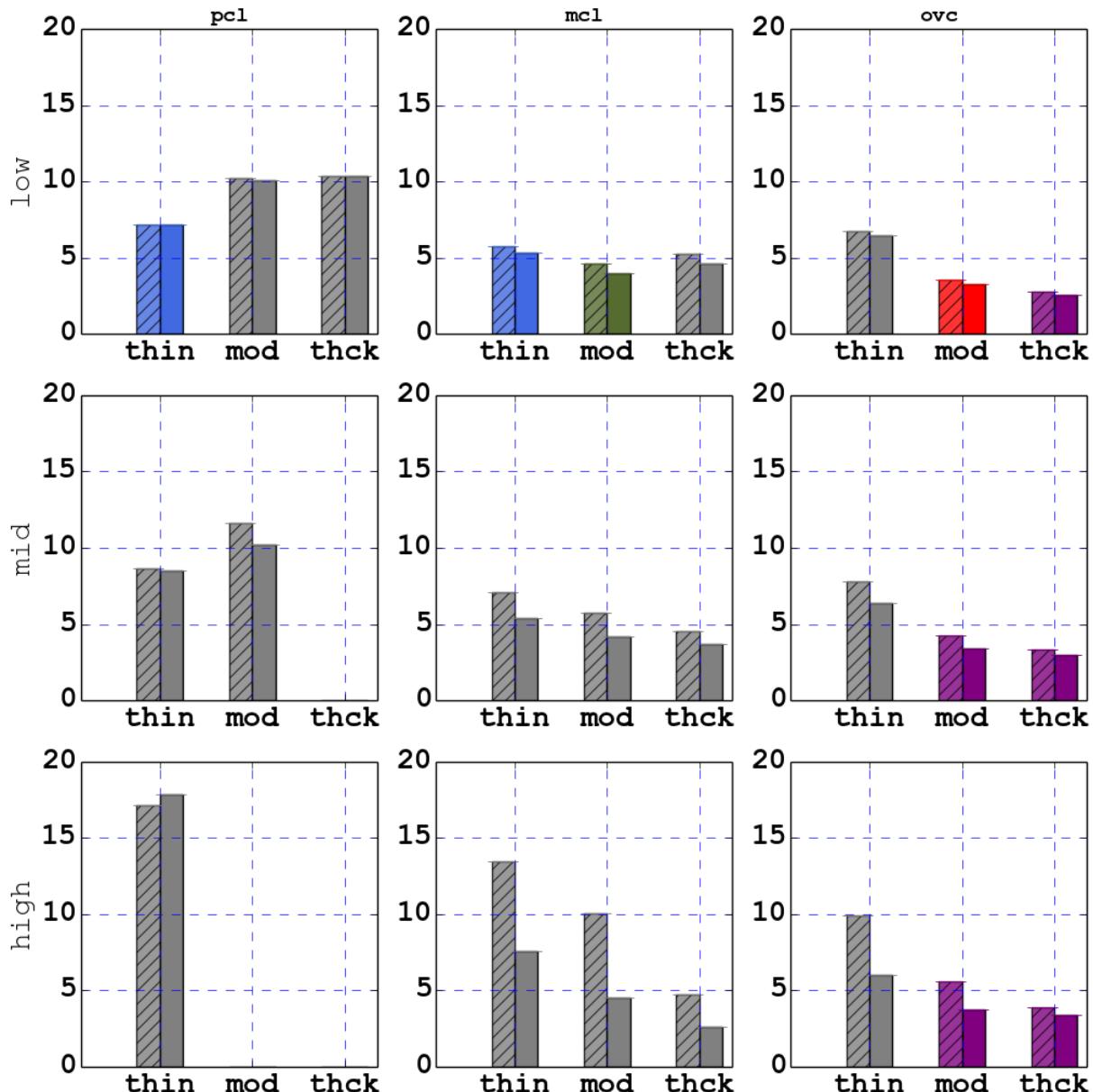
$$CV2_T^2 = CV_{ADM}^2 + CV_{NB}^2$$

- Parallax term is the difference between the level 1 and level 2

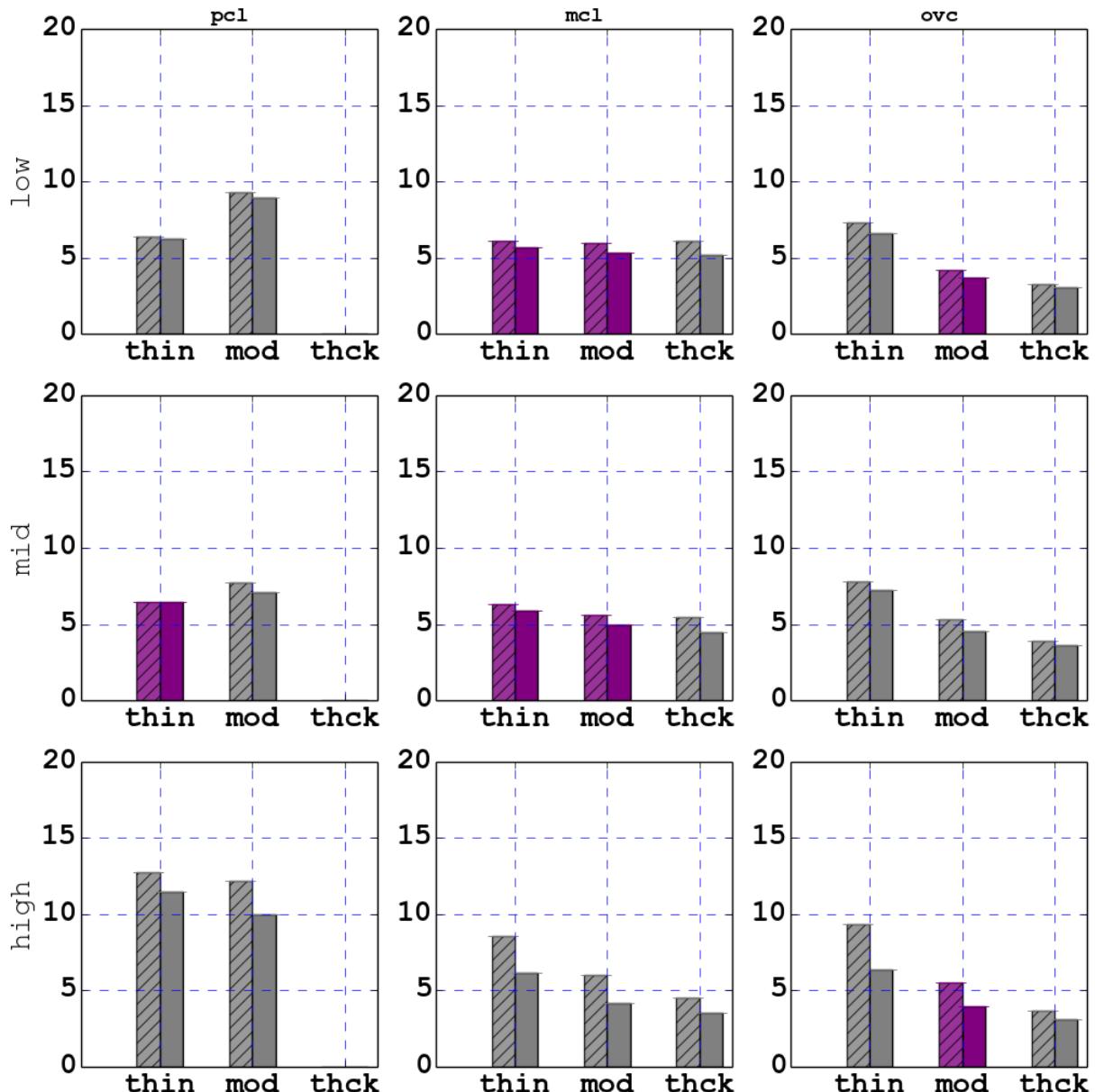
$$CV_{PX} = \sqrt{CV_T^2 - CV2_T^2}$$

- Still a work in progress
 - Some sampling issues
 - The results I show will be for the ***total error*** only

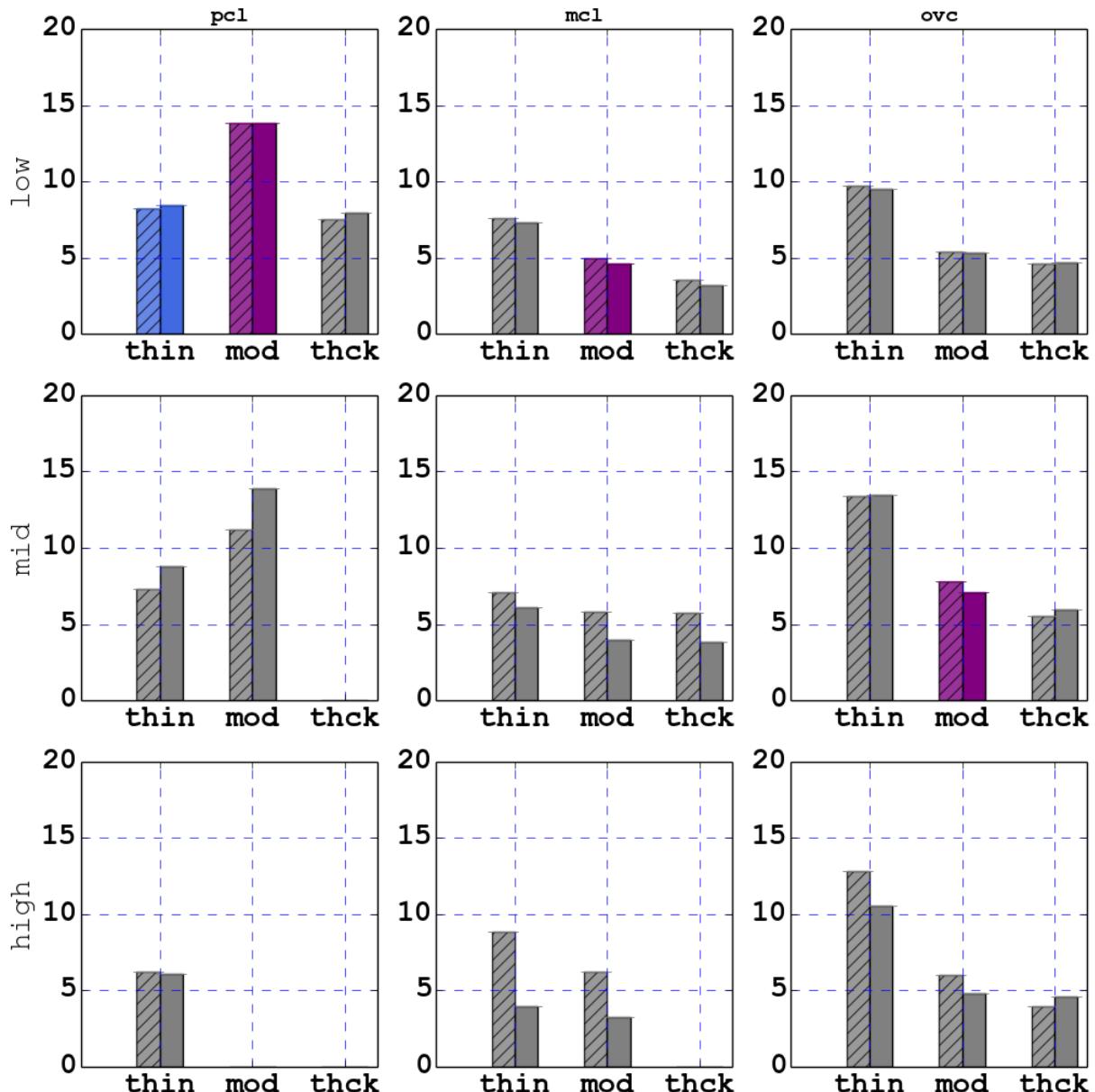
Single Layer Clouds: Ocean Both Levels (// = Level 1)



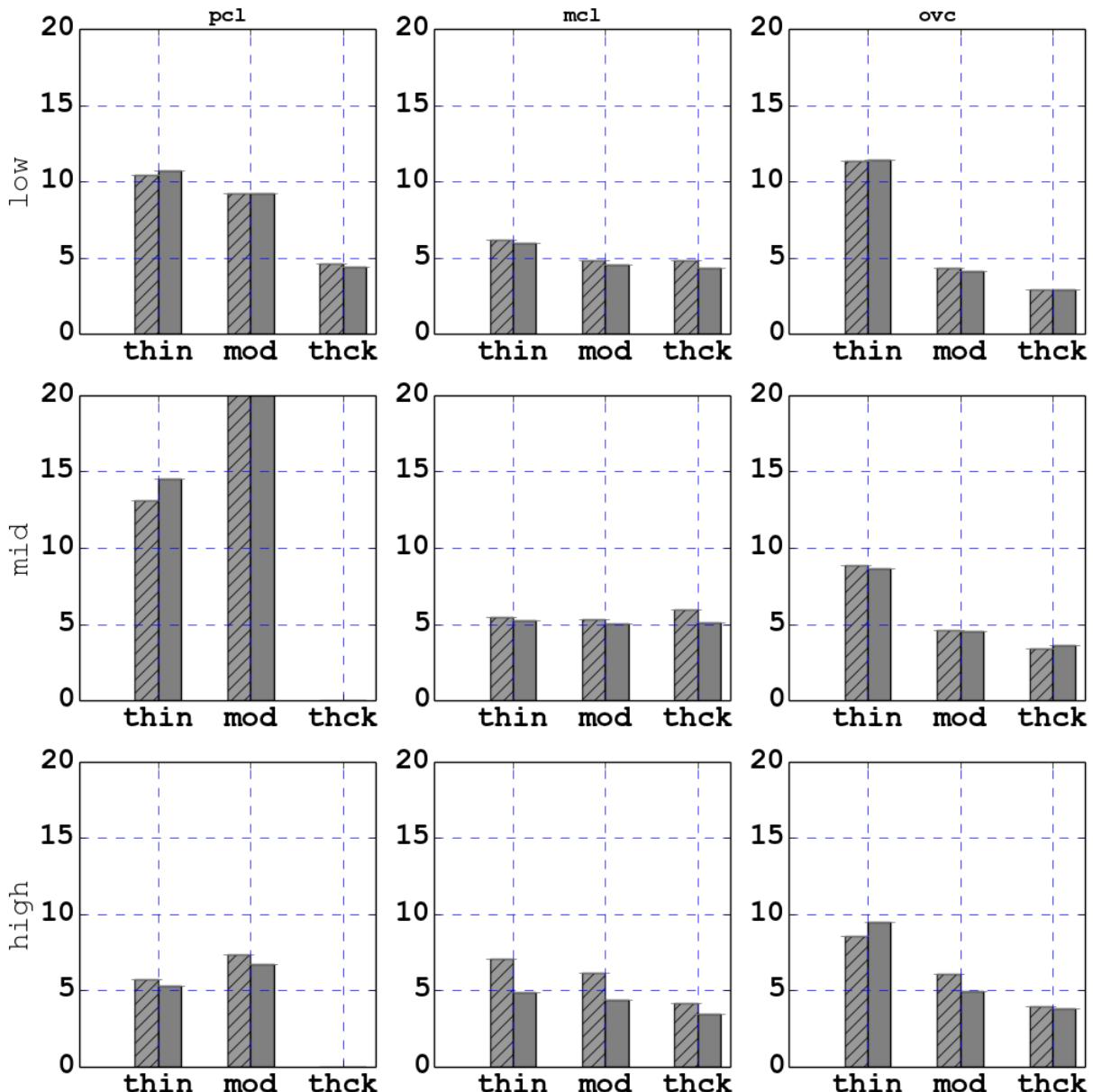
Multi Layer Clouds: Ocean Both Levels (// = Level 1)



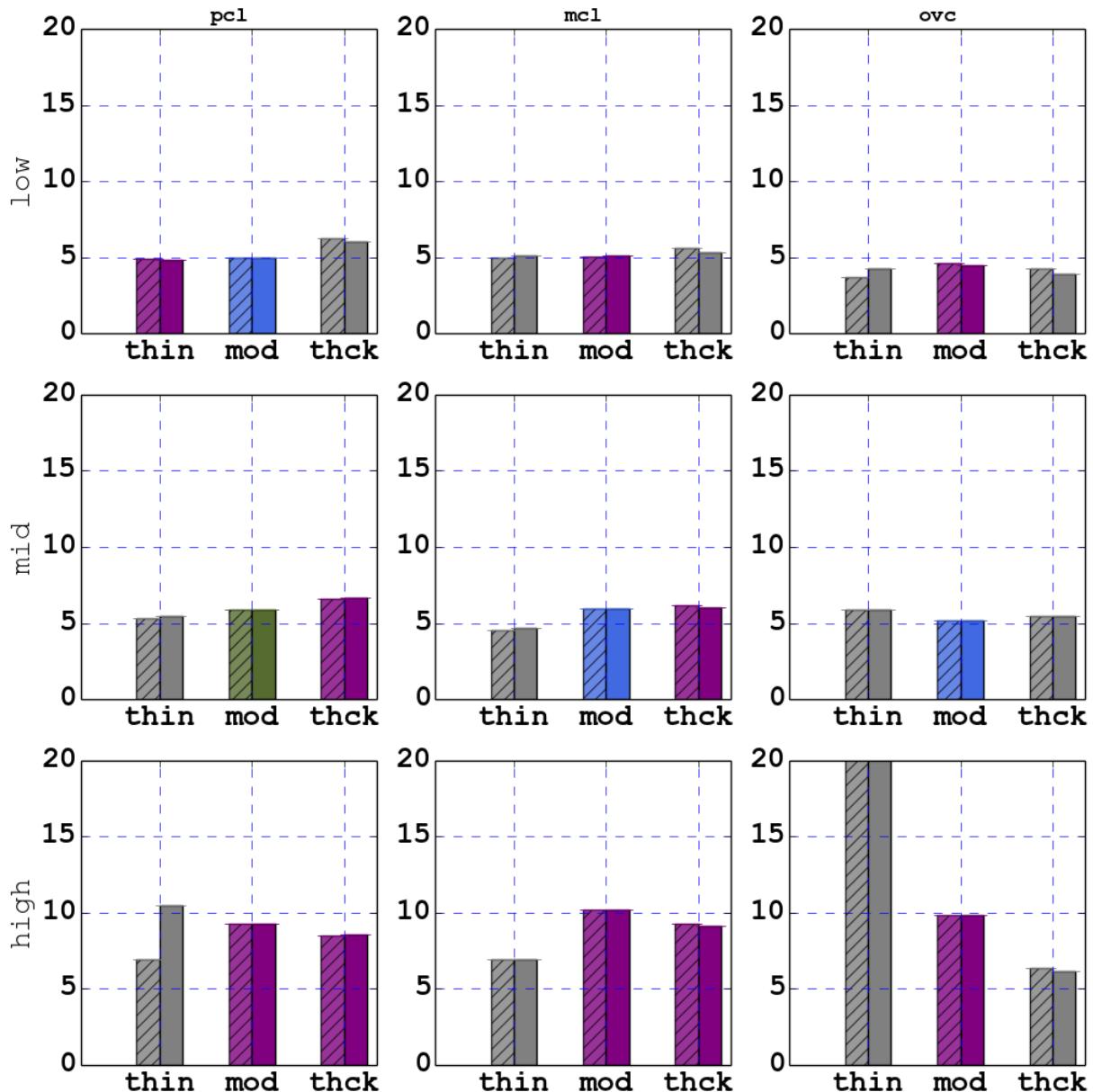
Single Layer Clouds: Land Both Levels (// = Level 1)



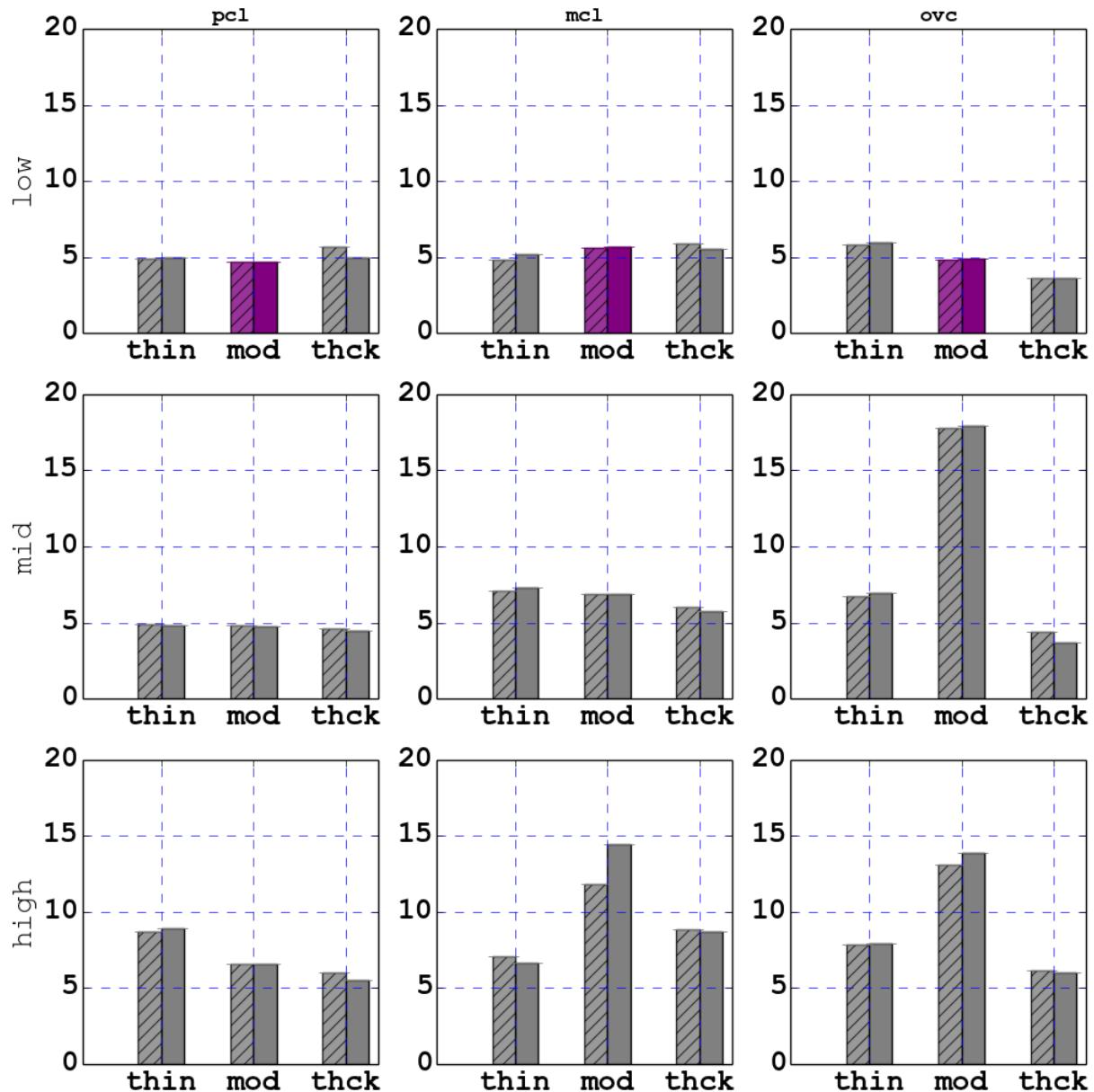
Multi Layer Clouds: Land Both Levels // = Level 1)



Single Layer Clouds: Snow/Ice Both Levels // = Level 1

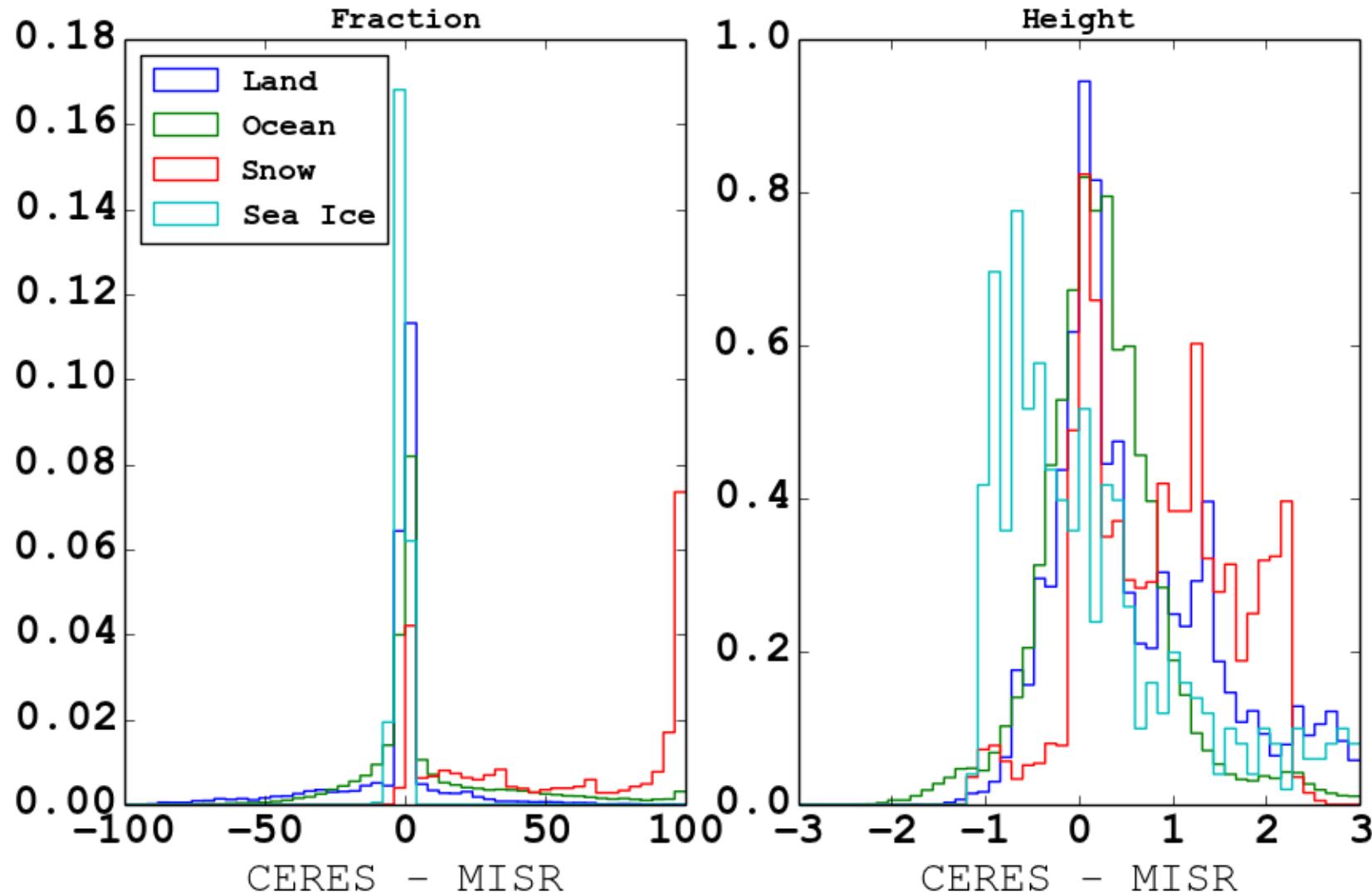


Multi Layer Clouds: Snow/Ice Both Levels (// = Level 1)

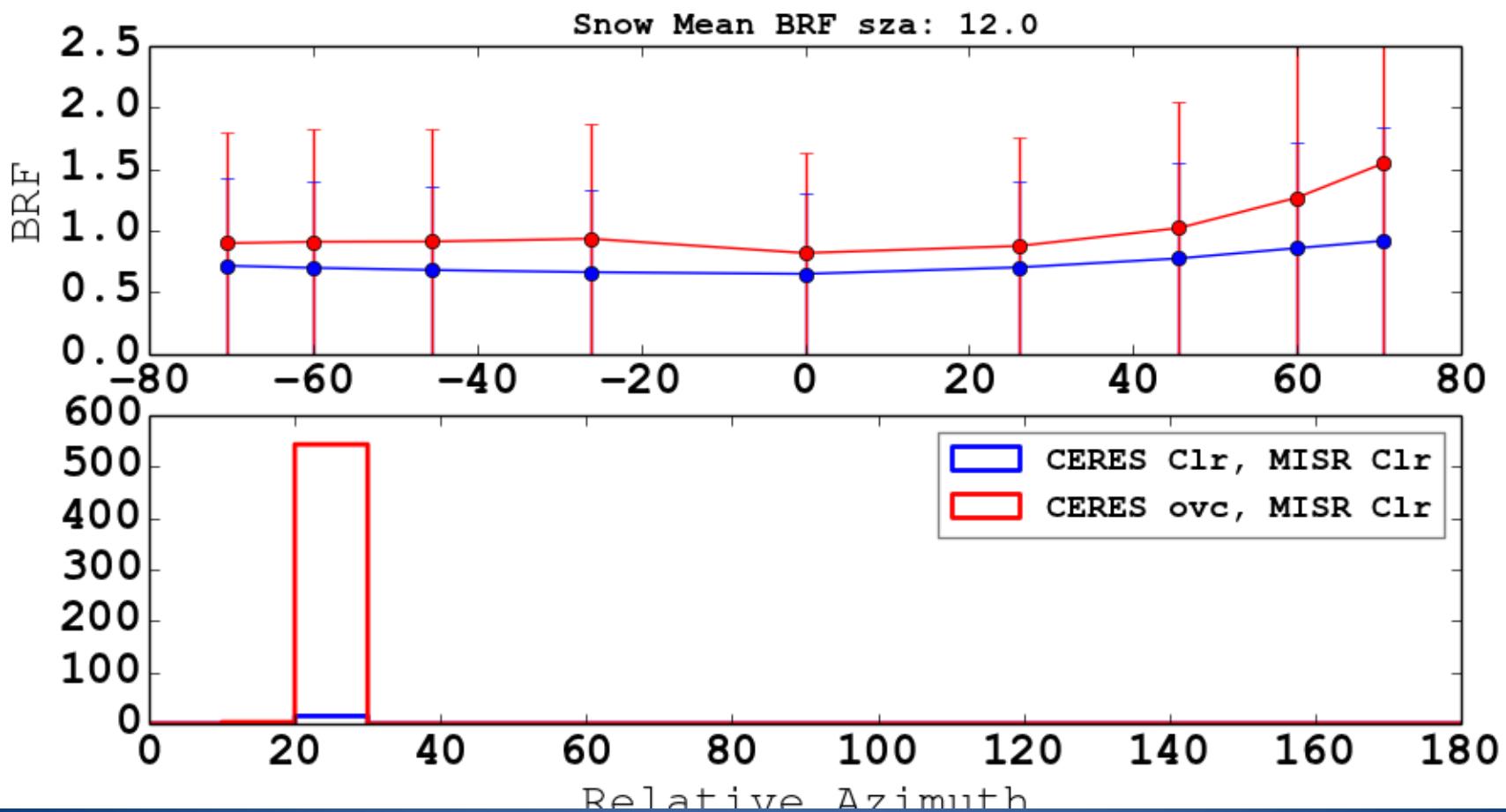


- Adding MISR clouds and Cloud Heights to the SSFM
 - MISR clouds are stereoscopically derived
 - Do not use spectral information
 - Independent test of CERES cloud mask
- MISR cloud product gives a cloud/surface flag at 1.1km area.
 - Also provides confidence

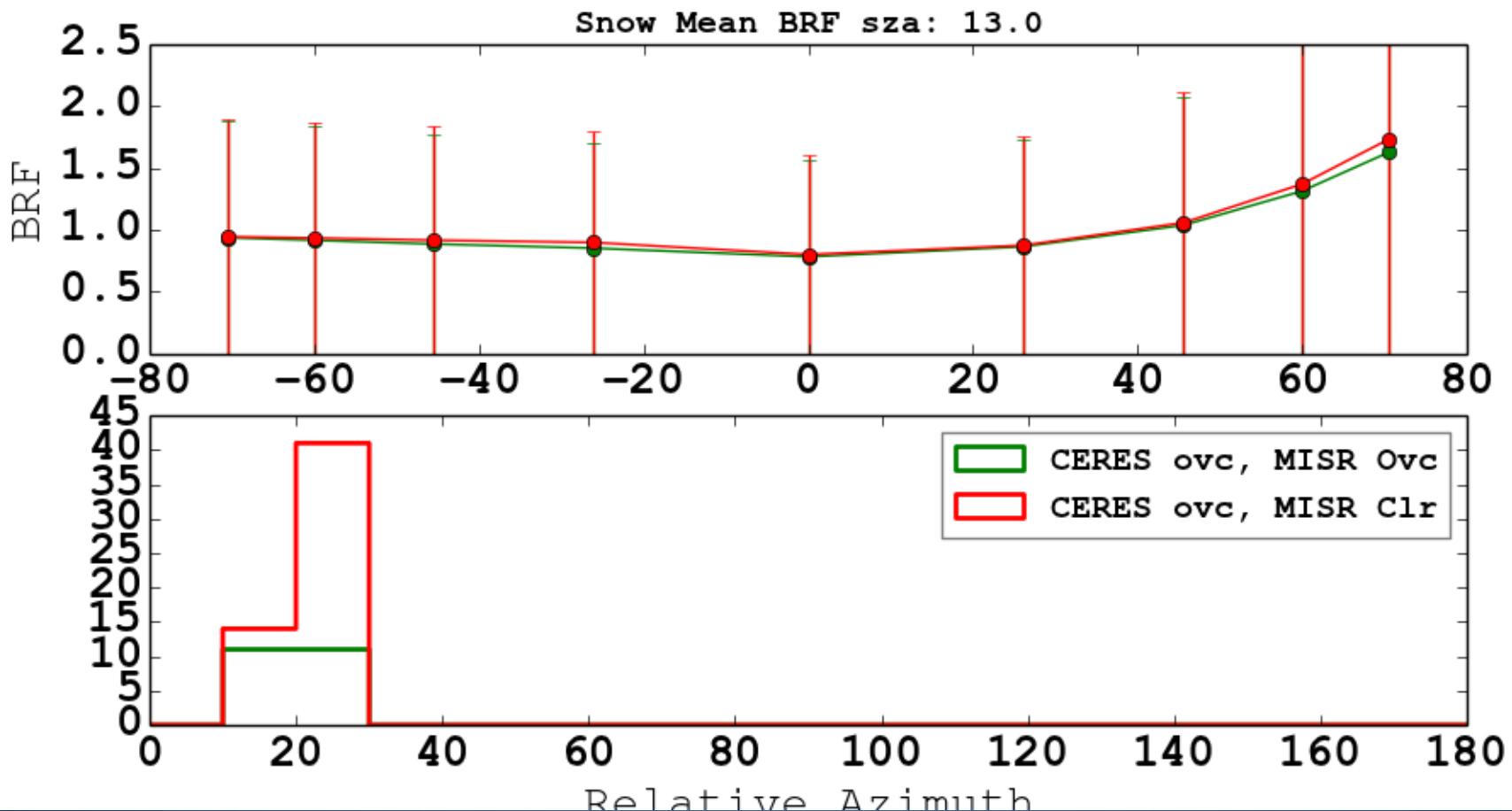
- Good agreement over land, water and sea ice
 - Just one day in August 2000



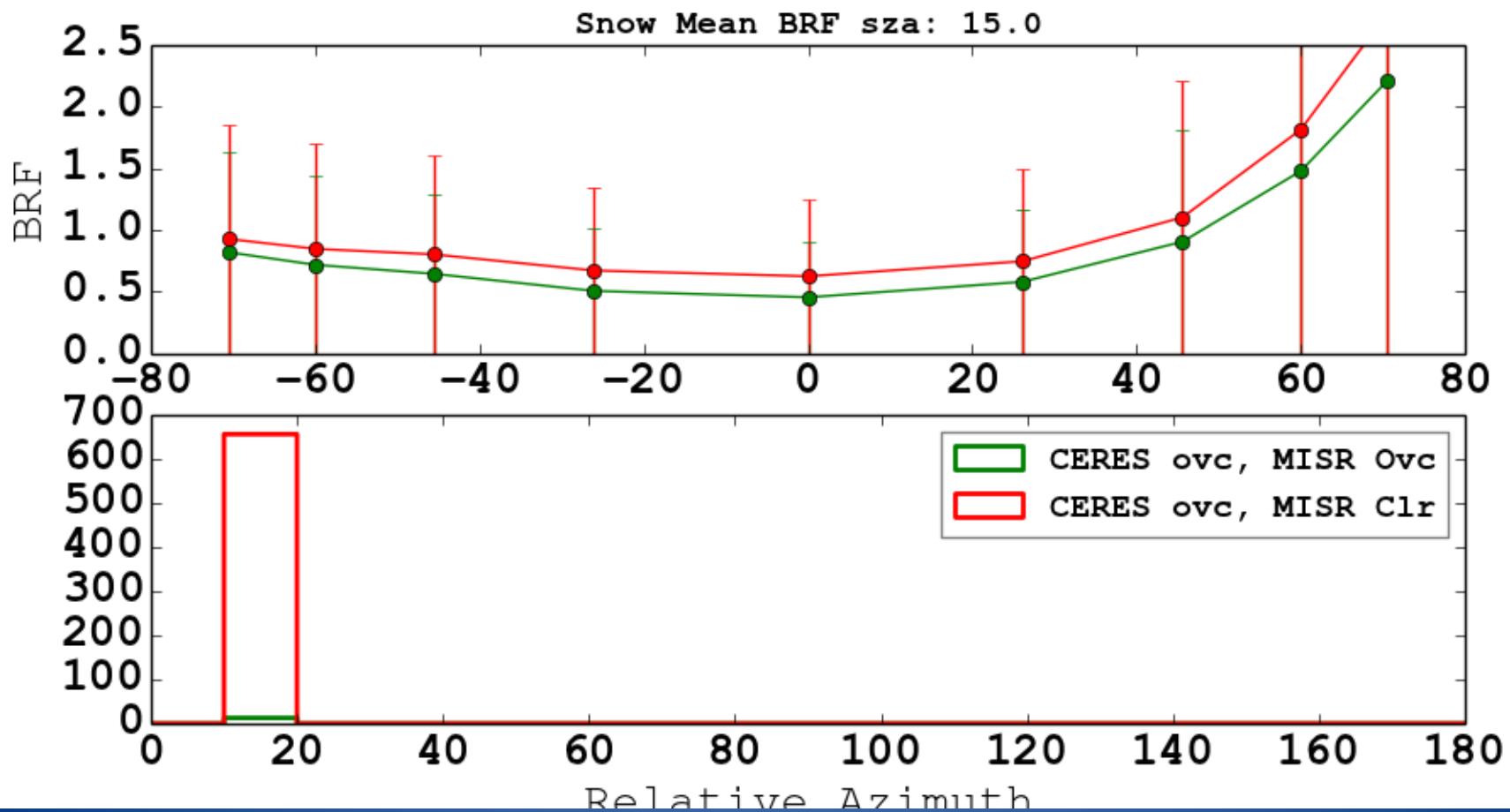
- The shape of the BRFs can give us a guide as to what surface we are looking at.



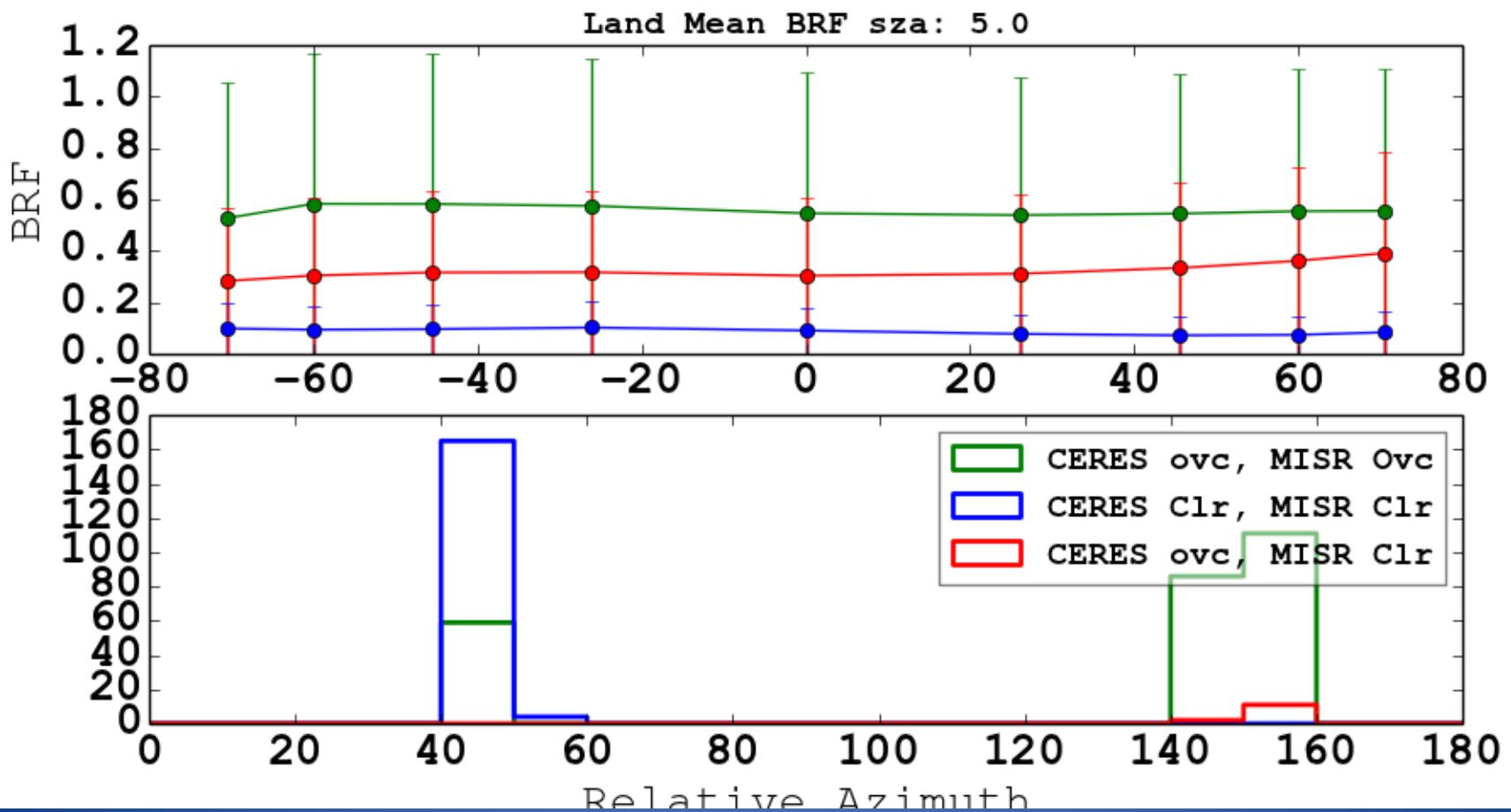
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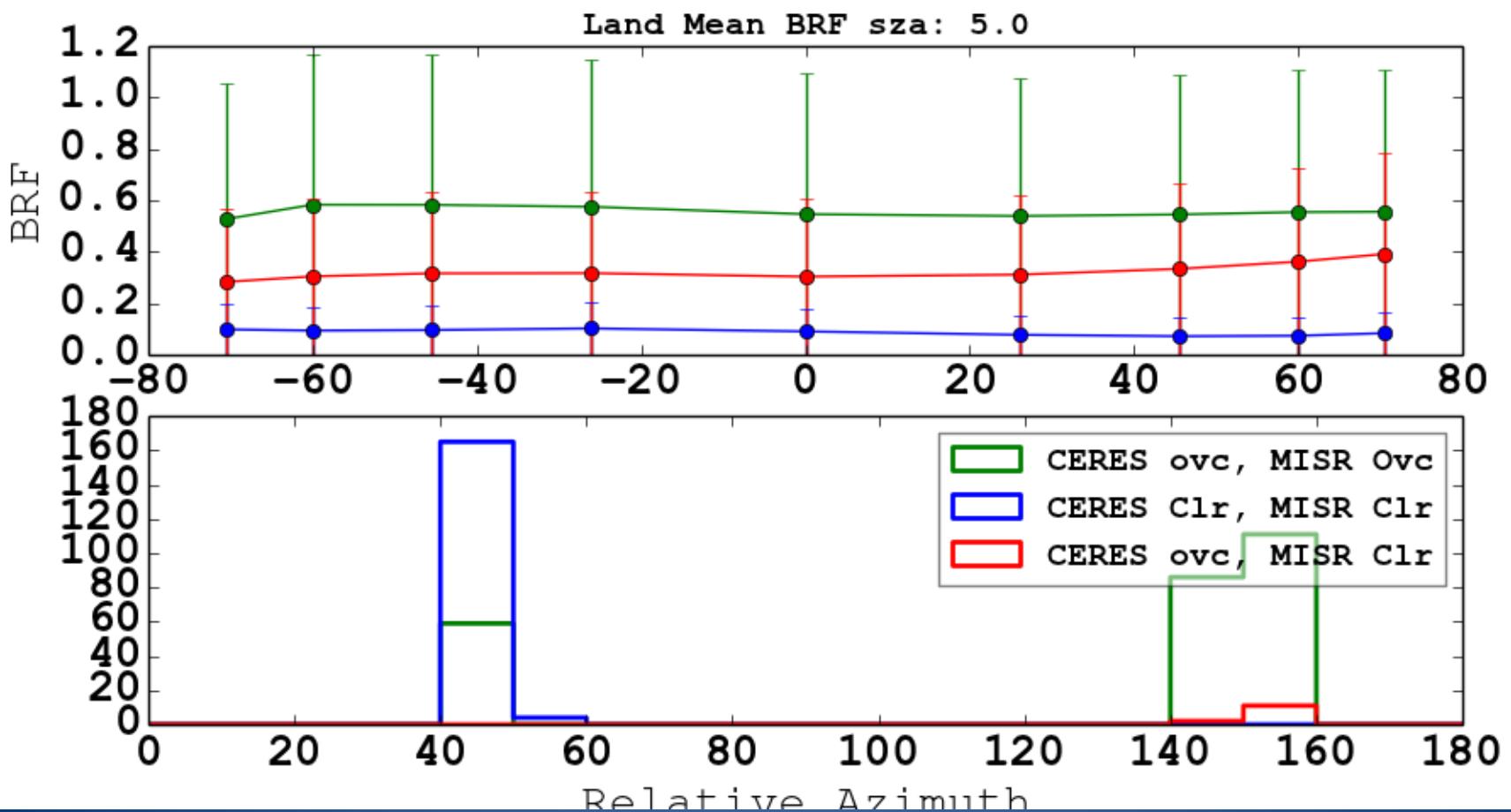
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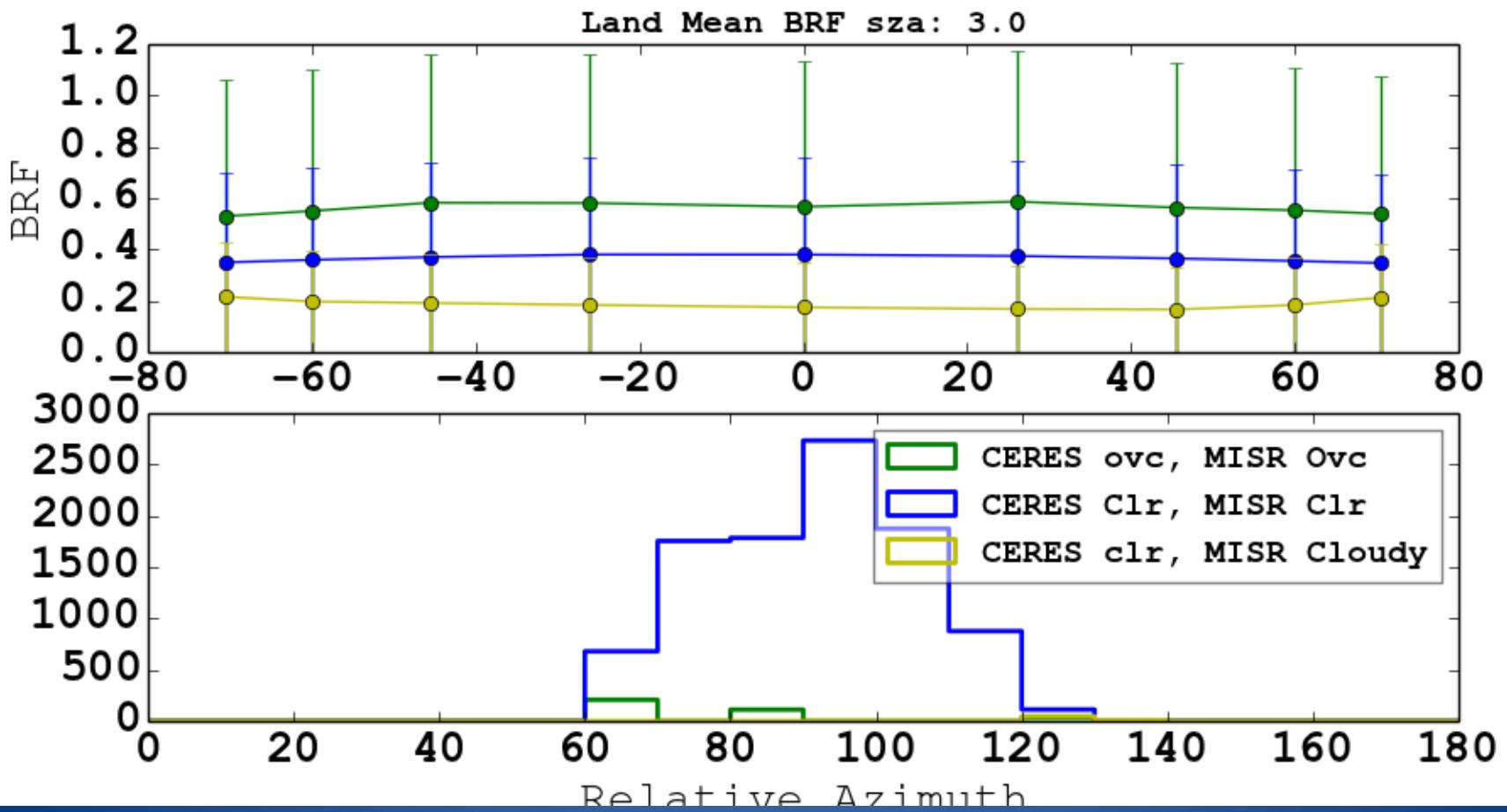
- CERES seems to outperform MISR over most scenes



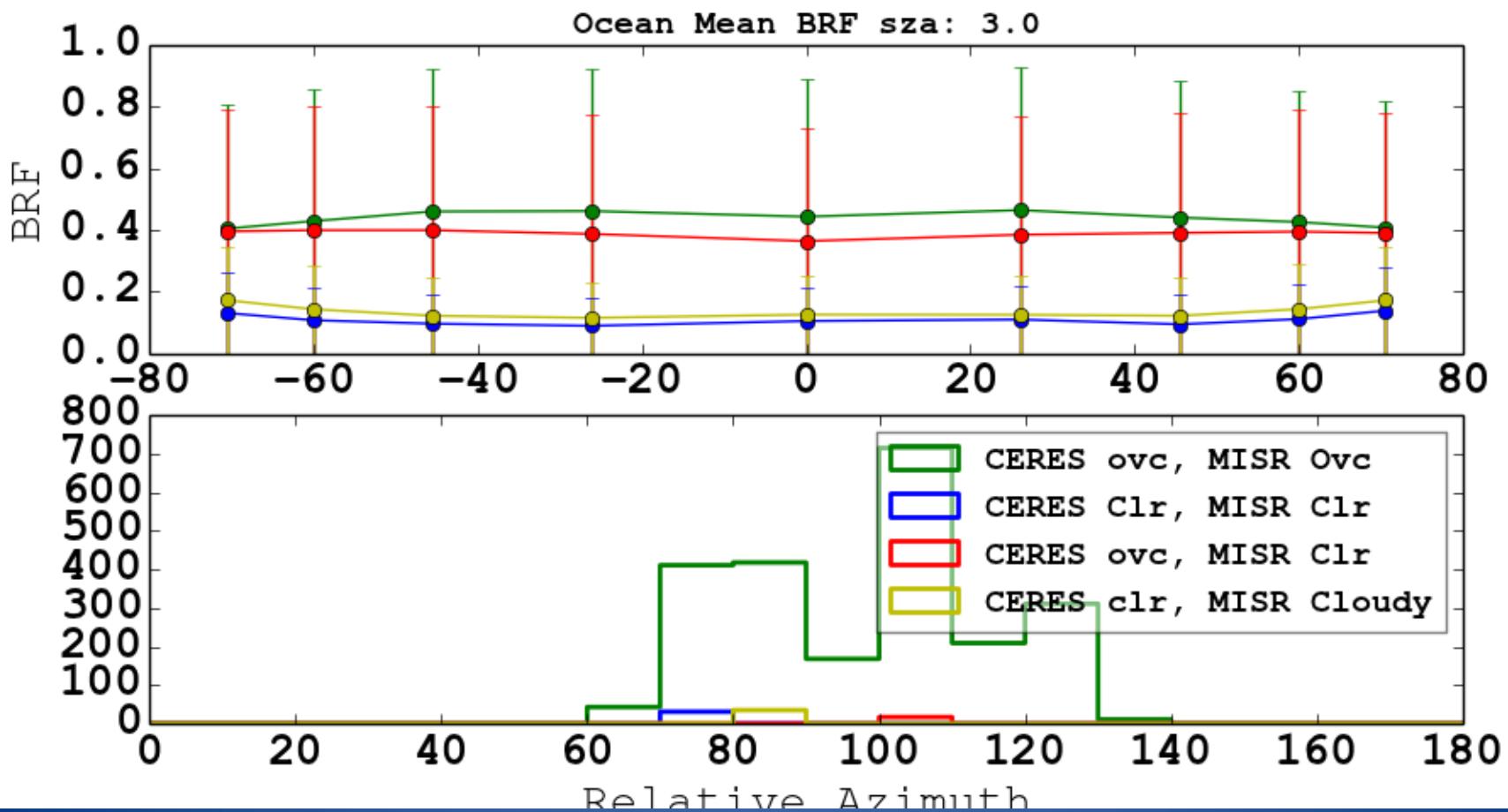
- CERES seems to outperform MISR over most scenes.
 - Land:



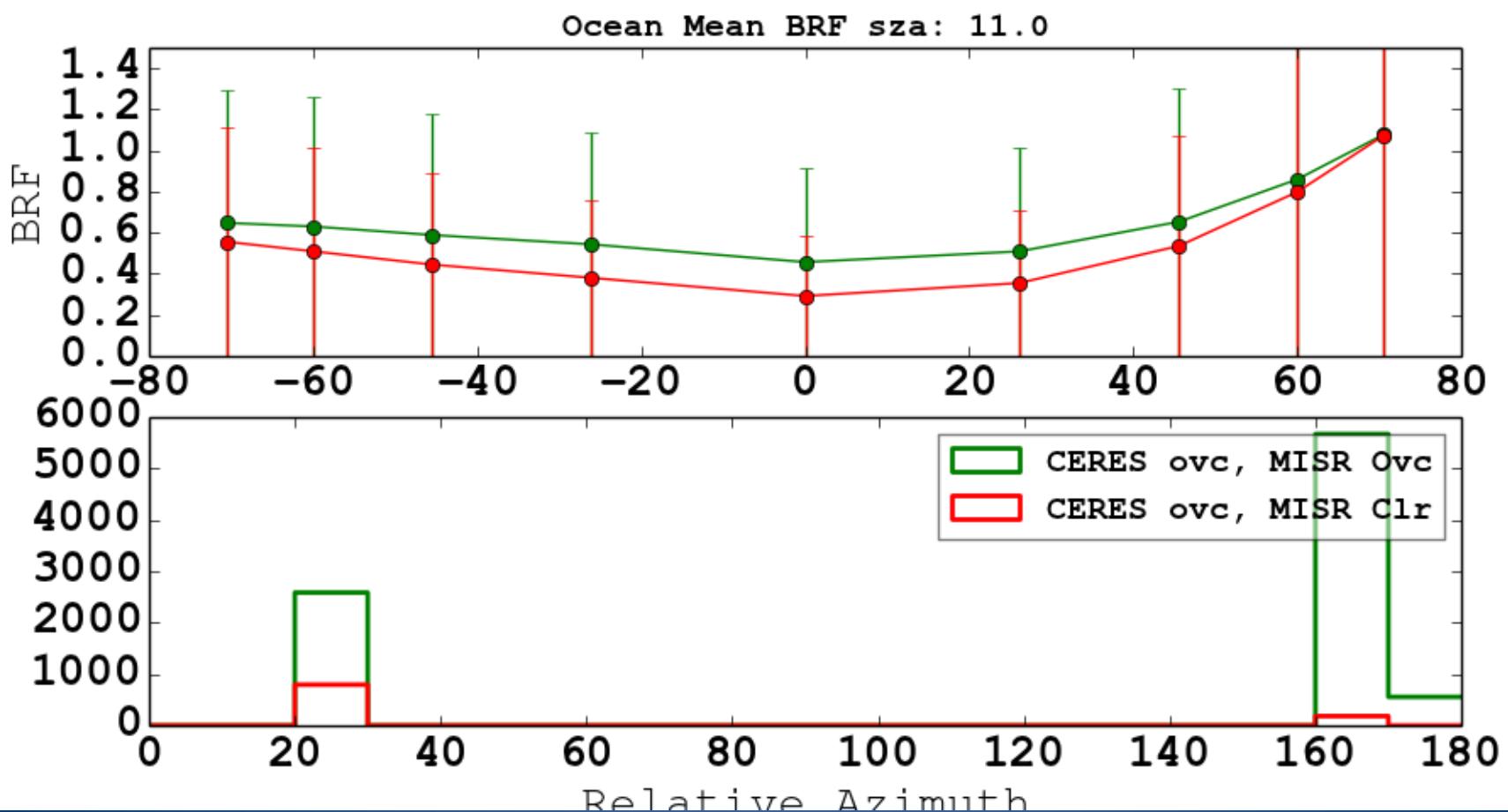
- CERES seems to outperform MISR over most scenes.
 - Land:



- Over ocean



- Over ocean



- Summary:
 - The level 2 MISR BRFs can be used to remove some of the parallax effects present in the SSFM dataset
 - We generally see an improvement in the angular consistency when using the level 2 MISR compared to the level 1 MISR.
 - Needs a bit more work to back out a parallax error term.
 - Cloud fractions between MISR and CERES are comparable (CERES better maybe?)